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Original Research Article

Outcomes of Full Pulpotomy in Permanent Teeth with Carious Exposures and Symptoms Indicative of Irreversible Pulpitis

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There are various dental issues that require evidence-based treatment to correct or treat to prevent patients from excessive suffering. Some of the issues include dental caries, trauma, and the side effects of dental treatments. The process of pulpotomy takes place after a tooth has been treated for a pre-existing condition. It can only be commenced after the removal of caries from the periphery of the pulp to prevent the occurrence of contamination during the process of pulpotomy. In total, 11 studies were included in the meta-analysis of the full pulpotomy procedure since they met the inclusion criteria. The articles addressed the concept of full pulpotomy and the biomaterials used and reported on the use of the procedure in treating mature teeth in adults. From the review of the included literature, it is clear that full pulpotomy is effective in treating adults' permanent teeth having irreversible pulpitis since it produces positive outcomes.

Keywords: Pulpotomy, Carious teeth, Irreversible pulpitis.

INTRODUCTION

The treatment of mature teeth with dental issues can be done using a number of therapies. One of the most successful therapies known in the dental world is root canal, which Meyer (2017) reports having a success rate of close to 100% when used on teeth with vital pulps. The root canal therapy (RCT) has become a common and effective method of treating irreversible pulpitis resulting from the exposure of the pulp in mature permanent teeth (Asgary, et al., 2017). However, RCT can result in problems for the patients if there are technical complications that arise during the performance of the process (Meyer, 2017). Furthermore, reports have it that RCT is quite expensive as compared to other dental procedures and it requires the patient to have multiple appointments with the dentist (Asgary, et al., 2017).

The clinician or dentist attending to a patient that requires RCT needs to have a high level of expertise especially when dealing with molars. To eliminate technical complications, clinicians and dentists need to perform histological examinations to identify the actual state of the pulp and avoid relying on patient history (Meyer, 2017). Meyer (2017) recommends the use of vital pulp therapy (VPT) methods, of which full pulpotomy is one.

By definition, pulpotomy refers to the process of "cutting the pulp" with a view to amputating an inflamed coral pulp while preserving the radicular pulp's vitality (Winters, et al., 2013). As a result of the radicular pulp's improved vitality, the primary tooth undergoes a normal exfoliation process. In essence, the pulpotomy cannot be carried out on necrotic pulps – pulps which have died since it aims at preserving the radicular pulp instead of mummifying it as was done in the 19th century (Winters, et al., 2013).

The process of pulpotomy takes place after a tooth has been treated for a pre-existing condition. It can only be commenced after the removal of caries from the periphery of the pulp to prevent the occurrence of contamination during the process of pulpotomy (Winters, et al., 2013). Furthermore, the elimination of carious debris eliminates the risk of exposing the pulp inadvertently. During the process, the dentist completely removes the roof of the pulp chamber and performs a clean cut of the coronal pulp at the base of the pulpal floor during the pulpal amputation (Winters, et al., 2013).

The best technique to use in the process is the high-speed rotary instrumentation, which helps prevent the creation of hemostasis at the site of amputation. Hemostasis normally results from the presence of tissue tags which are residues to the amputation process. The dentist must exercise caution during pulpotomy to prevent the tooth from getting infected and should extract the tooth fully in case of the perforation of the pulp chamber.

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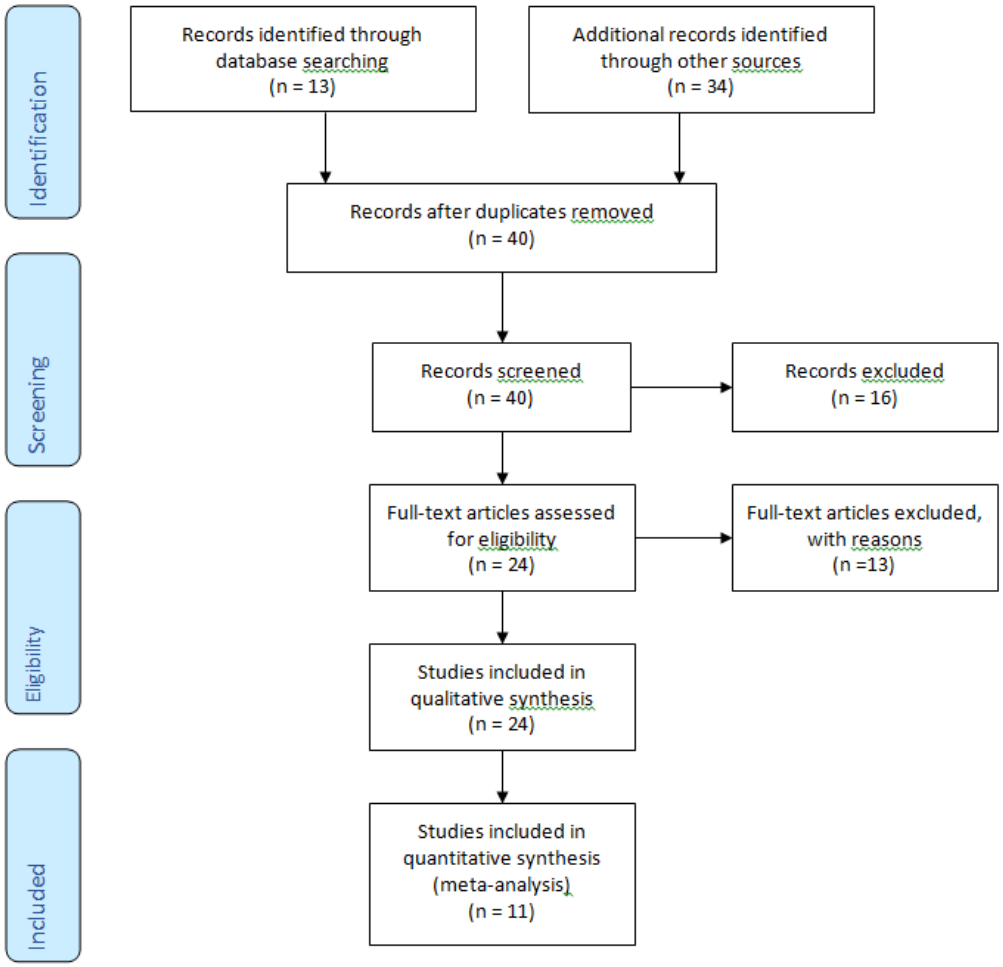

Systematic Review

There are various dental issues that require evidence-based treatment to correct or treat to prevent patients from excessive suffering. Some of the issues include dental caries, trauma, and the side effects of dental treatments (Winters, et al., 2013). These three issues usually produce a biological response of the teeth's pulpo-dentinal complex, which can lead to various complications that worsen the patients' dental conditions. Consequently, there is a need for various methods of promoting the treated teeth's adaptation and biological response to the processes of treatment. With the appropriate treatment, it is then possible for the teeth to grow and develop optimally (Winters, et al., 2013).

When the treatment of teeth results in inflammations of the coral pulp and threaten the vitality of radicular pulp, the method that becomes most effective is pulpotomy (Winters, et al., 2013). Pulpotomy then becomes a therapeutic effort that retains the carious of the traumatized teeth, restores the affected tooth's normal functions, and alleviates the patient from the clinical symptoms associated with the side effects of previous treatments. As a pulpal therapy, pulpotomy not only stabilizes the primary tooth but also helps in creating a suitable environment for the normal operations of the neighboring teeth. At the same time, it promotes the development of the enamel after the exfoliation of the primary tooth (Winters, et al., 2013).

Identification

During the identification process, a search of various online databases yielded 24 records that addressed the topic of pulpotomy and its use in treating teeth that have irreversible pulpitis. The databases from which the articles were found include PubMed.gov, the Cochrane Library, and Elsevier.com's Embase Library. A search of other sources, majorly the internet, led to the acquisition of a further 34 records on the same topic. However, seven of the records obtained from the internet sources were similar to those obtained from the database. Therefore, after the elimination of the duplicates, the total number of records obtained was 40.

Screening

Of the 40 records obtained from the search process, only 23 articles qualified for eligibility assessment after the initial screening process, leading to the exclusion of 17 articles. The articles excluded had insight on various aspects of pulpotomy.

The articles by Winters et al. (2013) contributed to an understanding of the pulpotomy process while Meyer (2017) addressed the necessity of vital pulp therapy in treating pulpitis. The Children Dental Surgery Center (2017) makes a case for the use of pulpotomy in treating children with pulpitis while DrParsi answers the question of whether a child needs pulpotomy(Parsi, 2017). Smaïl-Faugeron et al. (2018) also document the treatment options for handling extensive decays in children's primary teeth.

Ashburn Children's Dentistry (2018) provides a report on the pulpotomy procedure while shedding some light into pulpectomy while Leprince (2018) explains the use of the process in treating irreversible pulpitis.Bimstein (2014) presents a lecture on the use of pulpotomy in treating primary teeth while the Dental Family (2018) and Moscattini Dental (2018) explain the differences between pulpotomy and pulpectomy. Pleis(2018) also compares the two procedures and presents Colgate's stance on the use of pulpotomy in adults while Rindelaub et al. join forces in defining the roles of pulpotomy and pulpectomy in treating children's dental issues (Rindelaub, et al., 2014).

Some of the records also addressed the procedural use of pulpotomy in the treatment of primary and immature permanent teeth. The American Academy of Pediatric Dentistry (AAPD) provides guidelines for diagnosing pulp issues and recommends the interventions as well as the situations when pulpotomy is desirable (AAPD, 2016). Sathyanarayanan (2017) details the guidelines for administering the procedure beginning from the indications for commencing it and ending with apexification techniques. Neiburger (2017) answers the question of whether adult pulpotomies need to be routinely done by investigating pulpotomy procedures and comparing them to traditional endodontics. Al-Dlaigan (2015), on the other hand, investigates the pulpotomymedicaments used in deciduous dentition to clarify the trends in pulpotomy.

Eligibility

There were two main criteria adopted for including articles in the study. The first criterion was that the article reviewed had to be reporting on the full pulpotomy procedure. However, the articles that reported on the use of various biomaterials were excluded. The second criterion is that the article needed to report on the use of pulpotomy in adult patients who have irreversible pulpitis or other tooth complications. 13articles that were assessed for eligibility were excluded from the study since they did not meet these criteria.

Consequently, the articles addressing the use of pulpotomy in treating children were excluded from the study. The first article excluded was by Memarpour, Fijan, Asgary, & Keikhaee (2018), who performed an investigation of the use of the CEM technique in treating 50 children aged between six and eight years. Even though all the children displayed complete success in the treatment of irreversible pulpitis following the procedure, the article was excluded since it did not address the use of pulpotomy in adults (Memarpour, et al., 2018). Similarly, in an earlier study on MTA pulpotomy, Frenkel, Kaufman, & Ashkenazi (2013) also reported that both white and gray MTA with the use of ferric sulfate (FS) yielded positive outcomes.

The article was excluded since the authors arrived at the conclusion after performing pulpotomy on 68 children having 86 carious primary molars (Frenkel, et al., 2013).Kathal et al.'s article was excluded due to its concentration on applying the MTA pulpotomy treatment to children aged between six and nine years (Kathal, et al., 2017). Nematollahi et al.'s article also had the same limitation, hence was excluded as it focused on 25 eight-year-olds (Nematollahi, et al., 2018).

The article by Alolofi, El-Sayed, & Taha (2016), who performed a study to evaluate the successfulness of pulpotomy using natural extracts on primary teeth was also excluded. They conducted the study on 20 children having 60 primary molars, performing formocresol, propolisethanolic extract, and thymus vulgaris extract procedures each on 20 teeth (Alolofi, et al., 2016). The propolis and thymus vulgaris procedures displayed better success rates as compared to formocresol(Alolofi, et al., 2016). Still, the overall success of the pulpotomy on the 20 children proved that it is a suitable procedure to use in treating children's primary teeth.

Nguyen (2014) reports on the use of full pulpotomy in the treatment of primary incisors. He adopts a randomized clinical trial among healthy children aged between 18 and 46 months, conducting assessments in six-month intervals for a cumulative 40-month period (Nguyen, 2014). The article was excluded since it addressed the use of the process among children. However, it proved that pulpotomy is effective in treating carious incisors.Yildiz & Tosun'sarticle was excluded since it only addressed the comparison of various pulpotomymaterials without assessing their outcomes on the individual patients (Yildiz & Tosun, 2014). Similarly, the article on the comparison of MTA with FS in pulpotomy treatment was excluded due to its focus on the comparison of the two biomaterials (Marghalani, et al., 2014). It is for the same reason that Ozmen & Bayrak's (2017) clinical study on 26 children was excluded.

Chandrashekhar & Shashidhar's (2014) article investigated the use of FS and its demerits while discussing the alternatives to its use as a biomaterial. The article, however, was excluded since it did not mention the outcomes of pulpotomy in treating irreversible pulpitis. Similarly, Reddy et al.'s pilot study on the use of FS and sodium hypochlorite in pulpotomy was excluded since they did not analyze the outcomes of the procedure on adults (Reddy, et al., 2017).

The other article that was excluded was Taha & Khazali's (2017) randomized clinical trial involving the use of partial pulpotomy. The basis for its exclusion was that it focused on partial instead of full pulpotomy even though it demonstrates good success rates and positive outcomes in treating irreversible pulpitis (Taha & Khazali, 2017). The patients in the study were 50 in number and were aged 20 years and above (Taha & Khazali, 2017). Cohn's (2013) article, however, was excluded principally because it did not contain actual patient outcomes. It was based on hypothetical scenarios in investigating the use of pulpotomy and tricalcium silicate material (Cohn, 2013).

Included

In total, 11 studies were included in the meta-analysis of the full pulpotomy procedure since they met the inclusion criteria. The articles addressed the concept of full pulpotomy and the biomaterials used and reported on the use of the procedure in treating mature teeth in adults. The authors of the included articles adopted various methodologies for analyzing the use of pulpotomy in adult patients with dental challenges as discussed in the next section.

REVIEW OF INCLUDED LITERATURE

Bimstein & Rotstein (2016) givea case for the use of pulpotomyin treating permanent teeth that have endured crown fracture as soon as possible. In their article, they mention that the use of pulpotomy in such a fractured tooth helps the reduce

the patient's chances of experiences pains and prevents the infection of the pulp or its necrosis (Bimstein & Rotstein, 2016). Furthermore, after performing a literature review to assess the outcomes of Cvekpulpotomies, the authors conclude that nine-day delays before the performance of pulpotomydo not have a major effect on the outcome of the process. However, if there are delays of more than nine days, the process may not yield the best results in eliminating pain and discomfort, preventing microbial pulp invasion, or ensuring the healing of the pulp and the periodontal layer of the affected teeth (Bimstein & Rotstein, 2016).

Bimstein & Rotstein (2016) also shed light on the prognosis of the teeth after the process of pulpotomy. They mention that the prognosis of teeth with 4mm of pulp exposures or less may be good, with the effect of exposures exceeding 4mm being unknown at the time of the article's publication (Bimstein & Rotstein, 2016). While investigating the prognosis of teeth with either closed or open apices, the authors also discovered that the teeth having open apices might show a better prognosis. Furthermore, after investigating the factors that may compromise the outcomes of pulpotomy, the authors concluded that one of the factors that reduce the effectiveness of the treatment is the occurrence of a luxation injury that reduces the supply of blood to the tooth and causes innervation (Bimstein & Rotstein, 2016). Therefore, the success of full pulpotomy depends on the prevention of bacterial infection of the tooth and an adequate blood supply to the injured tooth.

Taha & Abdulkhader (2018) investigated the outcomes of performing Biodentinepulpotomy on young permanent teeth that have carious exposures. In their investigation, they examined 14 adult patients who received pulpotomy treatment after the process done on their molar teeth that had carious exposure (Taha & Abdulkhader, 2018). The authors anesthetized the tooth of each patient, isolated them, and excavated the dental caries after disinfecting the teeth. They then performed full pulpotomy through the amputation of the exposed pulp of each tooth as far as the canal orifices' levels. They performed hemostasis using cotton pellets, used Biodentine of 3mm as the agent of pulpotomy, applied Vitrebond as the liner, and restored each patient's tooth(Taha & Abdulkhader, 2018). They performed radiography and clinical examination on each patient after six months and one year.

The results of the procedures that Taha & Abdulkhader (2018) performed indicated that all the teeth showed signs and symptoms that suggested the existence of irreversible pulpitis. Furthermore, each patient reported that they no longer experienced any pains within two days of the treatment. After the clinical examinations, the authors concluded that all teeth were healthy after the six-month and one-year periods. The patients that previously had immature roots displayed positive root development while five of the 20 teeth showed dentin bridge formation (Taha & Abdulkhader, 2018). Therefore, the authors concluded that Biodentinepulpotomy produced positive outcomes in treating teeth with carious exposure, with the teeth showing no contraindication of irreversible pulpitis. Borkar & Ataide (2015) also analyzed case reports on the use of Biodentinepulpotomy and concluded that the method can be recommended in treating pulp exposures in the permanent incisors that have experienced trauma.

Simon & Zanini (2016), in a report of the comparison of the processes of pulpotomy and pulpectomy, show the extent to which pulpotomy procedures contribute to positive patient outcomes. With the primary aim of comparing the rates of success of root canal treatments to those of pulpotomy, the authors indicate that pulpotomy, which is a conservative treatment method, is effective in treating inflamed dental pulp (Simon & Zanini, 2016). They also compare the clinical and biological factors that contribute to the prognosis of either treatment method.

Based on a case study of a 36-year-old patient, Asgary, Verma, & Nosrat (2017) report on the outcomes of pulpotomy as one of the alternative treatment options to handle irreversible pulpitis. From the case that they studied, the authors report that the patient had irreversible or hyperplastic pulpitis in his maxillary molars (Asgary, et al., 2017). Since the patient could not afford root canal therapy (RCT), had no dental insurance cover, and did not wish to have his teeth extracted, the dentist handling his case used the calcium-enriched mixture (CEM) pulpotomy procedure instead of extraction (Asgary, et al., 2017). After the procedure, the dentist produced radiographs and 3D images that showed the patient's periodontal ligaments (PDL) to be normal in all the roots of his teeth (Asgary, et al., 2017). Consequently, the authors concluded that pulpotomy is not only a viable alternative to the extraction of mature teeth that have irreversible pulpitis but also produces desirable patient outcomes. Solomon et al. (2015) also performed a case study to understand the process of managing acute irreversible pulpitis in permanent molars among adult patients. They also point out the successful outcomes of the procedure on preserving the vitality of the teeth and improving the process of tissue regeneration (Solomon, et al., 2015).

Similarly, Asgary&Eghbal (2013) conducted randomized clinical trials on the use of calcium enriched mixture (CEM) cement and mineral trioxide aggregate (MTA)pulpotomy procedures.The work was an improvement on an analysis conducted two years earlier recommended CEM to be an effective biomaterial in dressing the pulp (Malekafzali, et al., 2011). In their analysis of the 413 adult patients that they included in the study, Asgary et al. (2013) noted that the patients displayed clinical and radiographic success after 12 months (Asgary & Eghbal, 2013). Therefore, they concluded that pulpotomy procedures that employ both MTA and CEM biomaterials produce positive outcomes on the treatment of molars. The other established dressing materials that are associated with positive outcomes of full pulpotomy include ferric sulfate (FS) and sodium hypochlorite (Fernández, et al., 2013).

Kuo, Lin, Huang, & Chiang (2017) conducted a cohort study to determine the outcomes of various types of pulpotomy in the treatment of molars. The authors performed a retrospective study of 145 molars in a cohort to assess the rates of success of the pulpotomy procedures that employ diode laser, sodium hypochlorite, and no medication (Kuo, et al., 2018). The assessment of the success depended on the analysis of the clinical symptoms and signs after the procedures as well as the results of radiography done on each of the patients. The authors found out that the success rates did not differ according to the pulpotomy treatment type with the success rates measured after two years being 100% (Kuo, et al., 2018).

However, the major difference in the success rates was observed when the level of experience of the pedodontists was taken into consideration. The authors noted that the success rates reduced from 94% when experienced attending doctors performed the procedures to 58% when resident less-experienced doctors performed the procedures (Kuo, et al., 2018). Therefore, it is safe to conclude that pulpotomy produces positive patient outcomes when experienced dentists conduct the procedure.

Vidya, Patil, & Anegundi (2015) investigate whether pulpotomy is obsolete, answering their research question by assessing the success rate of pulpotomies in treating primary second molar teeth. After selecting 80 primary second molars from adult patients, the authors treated half the teeth using indirect pulp therapy (IPT) and the other half using MTA pulpotomy(Vidya, et al., 2015). Their results indicated that both IPT and pulpotomy displayed 100% success rates, leading them to conclude that pulpotomy still has positive outcomes and is, therefore, not obsolete (Vidya, et al., 2015).

CONCLUSION

The systematic review was conducted after an initial search involving 47 records –34 obtained from internet sources with 13 obtained from the library. After the removal of seven duplicates, 40 articles remained for screening. During the screening process, 16 records were excluded since they concentrated more on defining pulpotomy and explaining the procedures involved in the pulpotomy process using various biomaterials. The remaining 24 articles were assessed for eligibility, with only 11 being included since they satisfied the criteria of the use of full pulpotomy and its outcome after being used in treating adults. From the review of the included literature, it is clear that full pulpotomy is effective in treating adults' permanent teeth having irreversible pulpitis since it produces positive outcomes.

CONFLICT OF INTEREST:

There is no conflict of interest among the authors of this systematic review.

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